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Nuclear Power as a Viable Resource

Electricity is a necessity for most people today. The vast amounts of energy needed to supply the demand can be generated in many ways, including burning coal or natural gas (fossil fuels) or using a nuclear reactor. Many people, however, do not support the use of nuclear power, even though it is a safe, clean, and useful form of power that should be used in place of current forms.

In order to understand why nuclear power is useful, it is necessary to understand what nuclear power is. The basis of nuclear power is a process called “nuclear fission”. The process generates enough heat to power an electric generator.

For nuclear fission to occur, there needs to be many heavy nuclei in fairly close proximity. With sufficient heat or another catalyst of some sort, fission occurs in one nucleus; this generates enough energy to start several other reactions. Immense amounts of heat and other radiation are created in seconds.

In a sentence, nuclear fission is the break down of a larger nucleus into two smaller ones of approximately equal mass (Britannica “History” 1). In more detail, there are several steps to fission. First, a heavy nucleus is bombarded with something such as a proton, neutron, alpha particle, or gamma radiation. The nucleus assimilates it for a few fractions of a second, but then breaks down in radioactive decay.

There are several types of radioactive decay (World Nuclear Assoc. “Nuclear Waste” 2).

First is alpha decay, which releases alpha particles. They can be blocked by your skin, and are not dangerous. Beta decay releases beta particles, which can be stopped with aluminum and are only slightly more dangerous than alpha particles. Finally, gamma radiation releases gamma waves, which can only be blocked with large amounts of water, lead, concrete, or an equally large or heavy barrier. Gamma waves are very high-energy and are extremely dangerous.

All three types of decay occur during nuclear fission. However, gamma decay is the only one that actually has any repercussions. Not only is it dangerous to biological life, but it has the energy to start a fission reaction in another nucleus. This reaction very quickly produces *more* gamma radiation, which can start more reactions, etc. Eventually, all the fuel is used up and there is only heat, gamma radiation, and lighter elements. These lighter elements are often radioactive themselves, and must be disposed of properly.

The rampant chain reaction will lead to a large explosion if uncontrolled, like in the bombs dropped on Japan to end World War II. However, the reaction can easily be controlled and its energy harnessed. Inside the core of a nuclear power facility are control rods, which are made of a substance that can absorb gamma radiation, such as lead. These rods can be used to slow or even stop the reaction (Macaulay 170). They keep the heat at a nominal level, which can be transferred to coolant water, turning it to steam and driving a turbine that generates electricity (Macaulay 171).

According to the Encyclopedia Britannica, nuclear fission has a long history. The term “nuclear fission” was first used in 1939 by Lise Meitner and Otto Frisch to describe the process. Development of it, however, had been underway for a while before that. The discovery of the neutron in 1932 prompted Enrico Fermi to bombard Uranium with neutrons in 1934. This produced what he thought were heavier elements, but “the results of these investigations . . . were

extremely perplexing, and confusion persisted until 1939 when Otto Hahn and Fritz Strassmann ...proved definitely that the ...elements were in fact [different forms of] barium, lanthanum, and other [lighter] elements ...” (Britannica “History” 1).

Nuclear power is much more clean than other forms of power, such as gas and coal; this is the major reason that it should be used in place of current plants. Most power today is generated from these fossil fuels. A standard 1000 MWe coal-fired plant requires 3.2 million tons of coal per year (World Nuclear Assoc. 5). This coal has to be mined, transported, and stored until it can be used. Furthermore, that cost is *not* usually factored into the cost of the plant (World Nuclear Assoc. “Nuclear Waste” 1).

When the coal is burned, it produces seven million tons of CO₂ (carbon dioxide) and sometimes even produces SO₂ (sulfur dioxide) (World Nuclear Assoc. 5). “Many people are concerned about the possible warming of the earth through enhancement of the greenhouse effect. About half of this is due to the steadily increasing carbon dioxide in the atmosphere over the past 150 years, largely from the burning of fossil fuels, particularly coal.” (World Nuclear Assoc. “Nuclear Waste” 5). Furthermore, sulfur dioxide is one of the main compounds that causes acid rain.

Coal also produces solid waste. About 200,000 tons of solid waste, mostly ash, are produced (World Nuclear Assoc. “Sustainable Energy” 4). This ash contains hundreds of tons of toxic heavy metals, such as arsenic, lead, and mercury. The metals must be disposed of properly, as the waste from nuclear power plants must be also (World Nuclear Assoc. “Sustainable Energy” 4).

By contrast, nuclear power requires a very small amount of reactants to generate its power. A standard 1000 MWe nuclear power plant only requires 25 tons of enriched Uranium a

year (though this means mining 50,000 tons) (World Nuclear Assoc. “Nuclear Waste” 5). The storage of this material is a little more difficult than it is for the fossil fuels due to its radioactive nature, however.

The waste from nuclear power is also fairly small. Only about 25 tons of waste must be taken from a nuclear reactor every year (World Nuclear Assoc. “Nuclear Waste” 4). This waste is stored underwater for several years and is then either disposed of entirely (as in the US and Canada) or is reprocessed (as in Europe) (World Nuclear Assoc. “Nuclear Waste” 4). Although the reprocessing and disposal can be expensive, the World Nuclear Association says, “Nuclear power is the only energy industry which takes full responsibility for all its wastes, and costs this into the product” (“Nuclear Waste” 1).

As the numbers show, nuclear power is much cleaner than the traditional fossil fuels. A standard nuclear plant requires about three million tons less material to operate than a fossil fuel plant. The waste of a nuclear plant, though very dangerous, is thousands of times less than a fossil fuel plant. Therefore, nuclear power is much cleaner than more traditional forms of electricity generation.

A common complaint is that nuclear power, even if it is much cleaner, is also much more dangerous than other forms. It is true that the waste is radioactive and thus very dangerous, but it can be properly dealt with. Accidents leading to many peoples’ injury or death, such as the Chernobyl meltdown, are often cited. Protocols, however, are now in place to deal with such situations so that they do not happen again. Many people also claim that the materials in a nuclear plant could be used to make a bomb; this is not true. Therefore, nuclear power is very safe.

According to the World Nuclear Association, there are three kinds of waste (“Nuclear

Waste” 2-3). Most radioactive waste is “low-level waste”, such as clothing, rags, tools, and filters. This waste can be compacted, incinerated, and buried in a shallow landfill. Next is “intermediate-level waste”, which can be reactor components, decommissioned reactor materials, etc. It is usually put into concrete and buried. However, some longer-lived intermediate waste must be disposed of deep underground (World Nuclear Assoc. “Nuclear Waste” 2-3). Finally, composing very little volume but nearly all of the radioactivity worldwide is “high-level waste”. This is what most people think about when talking about nuclear waste. High-level waste is the spent fuel from a nuclear reactor. Very special care must be taken when disposing of this waste (World Nuclear Assoc. “Nuclear Waste” 3).

When first taken from a reactor, the high-level waste generates a lot of heat and must be stored for several years underwater (World Nuclear Assoc “Nuclear Waste” 4). The water tanks are lined with concrete to prevent radiation from escaping into the environment.

In Europe, the cooled waste is reprocessed. As much as 97% can be recycled or taken out of the high-level waste. Among the components removed are non-radioactive uranium and plutonium, which is very valuable (World Nuclear Assoc. “Nuclear Waste” 4). Obviously, reducing the volume of the high-level waste significantly reduces the cost of disposing of it.

Whatever remains (or, in the USA and Canada, all of the high-level waste) is buried in borosilicate glass (commonly known as Pyrex, a very strong and heat-resistant glass). Many safeguards are in place so that the waste does not leak into the environment. The glass containers are put inside stainless steel to resist corrosion and buried deep underground in a stable, remote location (World Nuclear Assoc. “Nuclear Waste” 5).

Obviously, this disposal is very expensive. As stated above, however, the expense is factored into the consumer’s cost when buying the power. In the USA, the general amount is

0.1 cents for each kilowatt-hour, which is put into the disposal of the waste. More than 18 billion dollars has been collected in this fashion (World Nuclear Assoc. “Nuclear Waste” 4).

Nuclear proliferation, or the use of materials in a nuclear power plant to make an atom bomb, is another concern. Reactors must be designed with this in mind. However, the enriched uranium which is used in most of the world’s nuclear power plants is not concentrated enough to make an atomic bomb (Wikipedia “Nuclear Reactor” 5).

When arguing against nuclear power, the accidents resulting from its use are often cited. The best-known and most often cited nuclear accident is the meltdown at Chernobyl. On April 26, 1986 there was a meltdown at the fourth reactor at the Chernobyl power plant which dispersed radioactive waste into the atmosphere and directly caused the deaths of 31 people (though many others have suffered or died from radiation poisoning) (Wikipedia “Chernobyl Accident” 1).

The reactor was undergoing a test, and many factors contributed to the meltdown. Primarily, an unsafe reactor and untrained operators were the causes. When the output of the reactor fell much lower than expected during the test, the control rods (which stop a complete chain reaction in the reactor) were removed more than necessary to increase output. When the power level skyrocketed, the rods could not be inserted again fast enough to stop an explosion. When the reactor did explode, a secondary layer should have stopped the release of radioactive components into the atmosphere; this layer was intentionally left out for cost reasons (Wikipedia “Chernobyl Accident” 1-2).

An accident such as this would not be able to occur today. Safety being too expensive was the ultimate cause of the meltdown; the world today does not have the same monetary problems as Soviet Russia did at the time. The staff today are much better trained, and extra

shielding is in place to prevent the release of radioactive components into the atmosphere in the event of an accident. Alexander Yuvchenko, who was working at Chernobyl at the time of the accident, says, “I’m fine about [nuclear power], as long as safety is put head and shoulders above any other concern, financial or whatever. If you keep safety as your number one priority at all stages of planning and running a plant, it should be OK” (Bond 3). As these safety considerations are taken into account today, nuclear power is a very safe source of energy.

Nuclear power is a superior source of energy when compared to current fossil fuel plants. It is many times more clean and efficient than coal and gas power, both in resources used and in waste produced. Although the waste from nuclear power can be very dangerous, it can also be perfectly safe if the proper precautions are taken.

With the use of nuclear power, we can help the environment due to the efficiency of nuclear fission over fossil fuels. Currently, this form of energy is vastly underused; hopefully it will be used more often in the future!

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